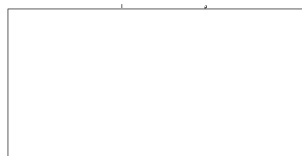
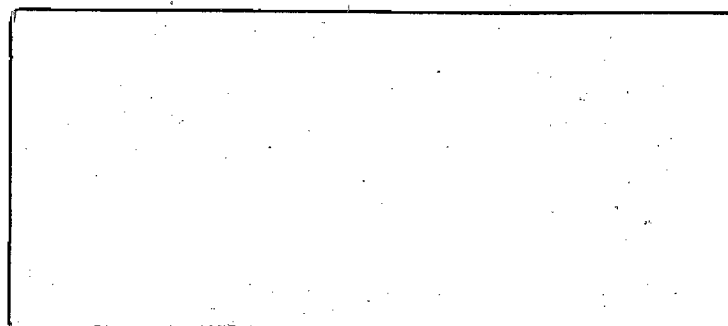
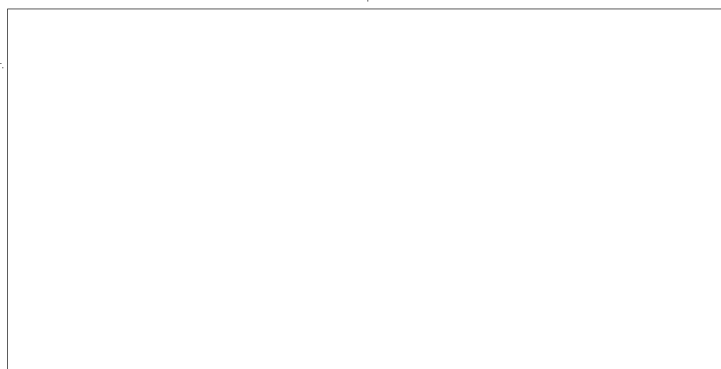


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INSTRUCTION MANUAL
FOR
CONFIDENTIAL
PORTABLE INTERCOMMUNICATION SYSTEM

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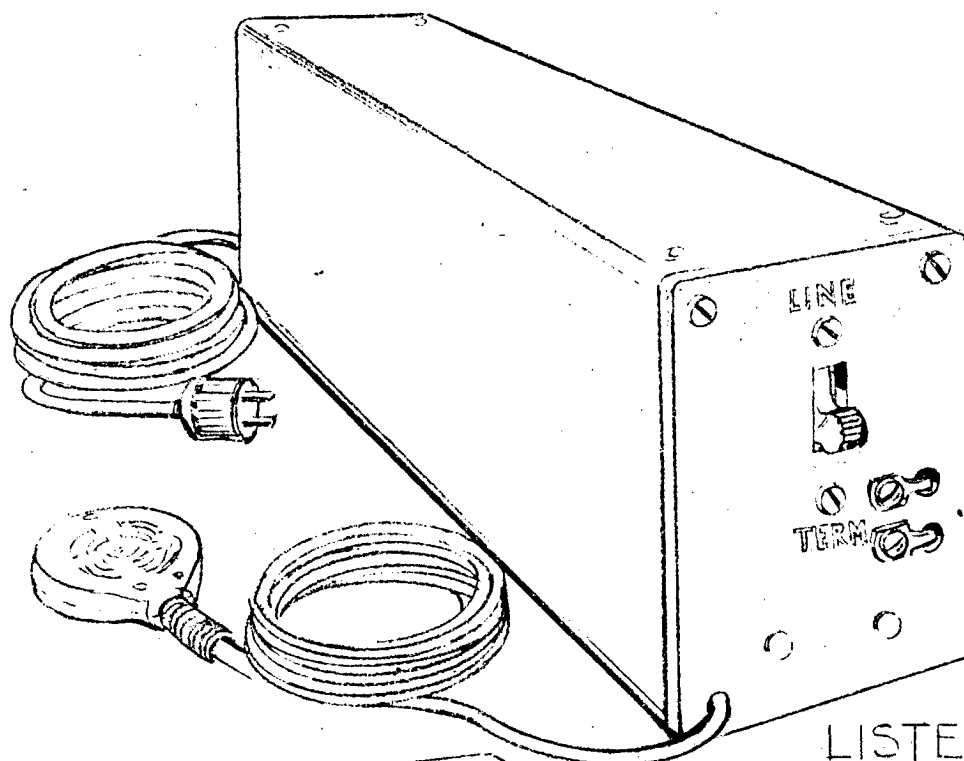
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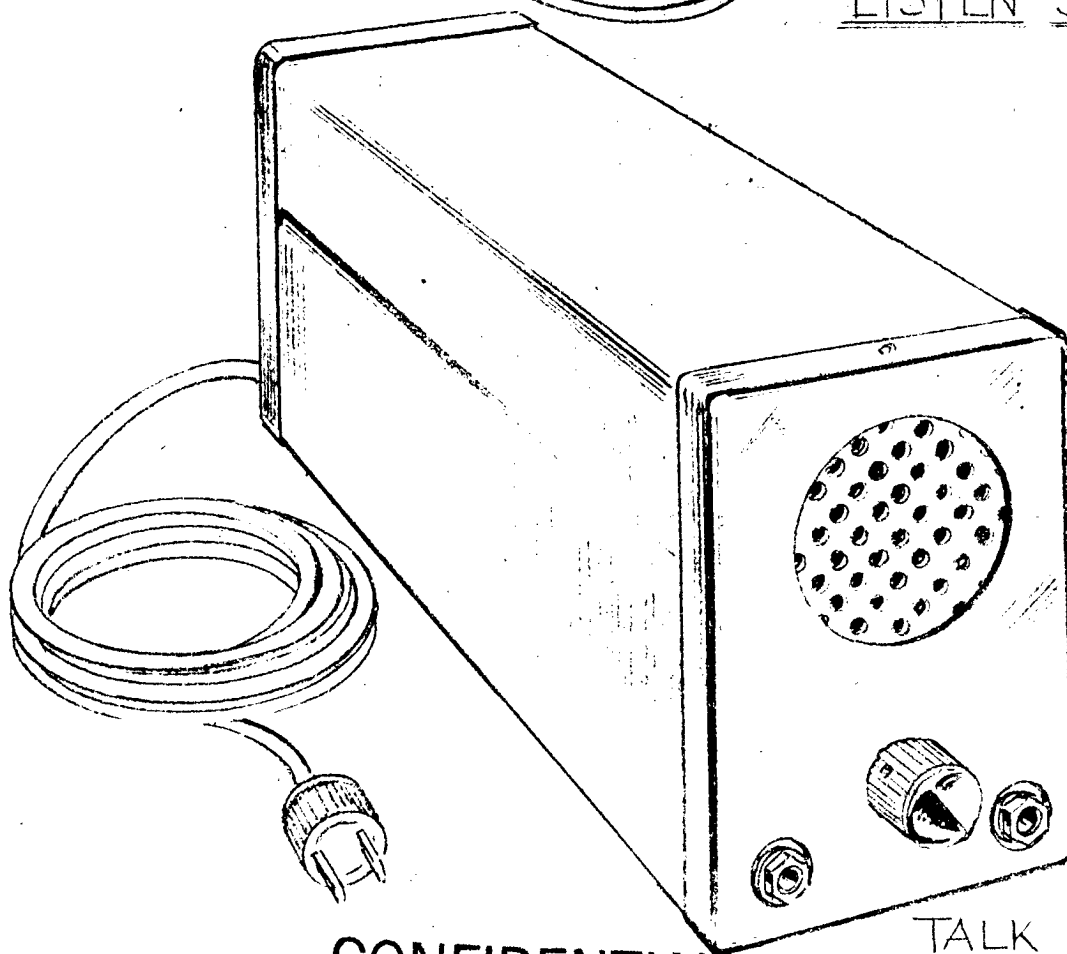
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LISTEN STATION



TALK STATION

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FIGURE 1. Portable Intercommunication System.

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DESCRIPTION

Introduction

This manual contains instructions for the operation and maintenance of a Portable Intercommunication System, and includes a brief theory of operation.

General Description

The system is composed of the two major components shown in figure 1. The LISTEN station consists of a frequency-modulated transmitter and a control receiver; the TALK station contains the corresponding f-m receiver and the control transmitter. Two bands of operating frequencies are available: the low band f-m channel is tuned to 120 kilocycles and the control carrier to 75 kilocycles; the high band f-m channel is tuned to 160 kilocycles and its control carrier to 90 kilocycles. Each pair of units is factory-tuned to one of the bands of frequencies. The units are similar in appearance; the only external feature identifying the frequency to which a particular unit is tuned is a color-coded mark on the rear panels.

The stations operate from a power source of 115/230 volts, 50/60 cycles. The power lines may be used to carry the transmission between the stations, or an external transmission line may be connected to terminals provided. Technical characteristics for the LISTEN and TALK stations are given in tables 1 and 2, respectively.

The LISTEN station is housed in a phenolic box 11-9/16" long x 2-1/2" wide x 3-1/4" high, and weighs 4.7 pounds. The front panel mounts the TERM-LINE switch, the connecting terminals for the external transmission line, and the opening for the microphone cable. The power cord enters the rear panel, which mounts the 115V-230V switch. Internal adjustments are provided for tuning.

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The TALK station is enclosed in a metal case 10-11/16" long x 3-1/2" wide x 4-3/8" high, and weighs 6.1 pounds. Two phone jacks and the volume control extend through the front panel which covers the 2-1/2" speaker. The TERM-LINE switch, the 115V-230V switch, and the XMIT-OFF switch are accessible at the rear panel. The plate identifying the three switches is attached to the rear of the case by screws to facilitate removal. Tuning adjustments are internal.

TABLE 1. LISTEN STATION TECHNICAL DATA

CHARACTERISTIC	LOW BAND	HIGH BAND
Rear panel color-coded mark	Brown/Red/Violet	Brown/Blue/White
F-m transmitter:		
Frequency	120 kc	160 kc
Power output - *LINE operation	0.25 w	0.25 w
**TERM operation	0.50 w	0.50 w
Maximum deviation	± 2 kc	± 2 kc
Control Receiver:		
Frequency	75 kc	90 kc
Sensitivity	0.05 uw	0.05 uw
Selectivity 6 db	±3.5 kc	±3.8 kc
20 db	±5.5 kc	±6.5 kc
80 db	+27 kc	+36 kc

* For LINE operation, output into 1 ohm.

** For TERM operation, output into 500 ohms.

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TABLE 1. LISTEN STATION TECHNICAL DATA

(cont)

POWER INPUT	STANDBY	OPERATING
115 V 60 cps	2.7 w	8.5 w
230 V 60 cps	2.2 w	7.2 w

TABLE 2. TALK STATION TECHNICAL DATA

CHARACTERISTIC	LOW BAND	HIGH BAND
Rear panel color-coded mark	Brown/Red/Violet	Brown/Blue/White
<u>F-m receiver:</u>		
Frequency	120 kc	160 kc
Sensitivity (for 20 db quieting)	5.0 uw	5.0 uw
Selectivity 6 db	± 4.5 kc	± 4.9 kc
20 db	± 6.5 kc	± 8.3 kc
80 db	$+30$ -26 kc	$+44$ -29 kc
Discriminator output (± 2 -kc deviation)	3.5v rms	3.5v rms
Audio output (for 10% distortion)	0.6 w	0.6 w
<u>Control transmitter:</u>		
Frequency	75 kc	90 kc
Power output LINE operation*	0.5 w	0.7 w
TERM operation**	1.5 w	1.5 w

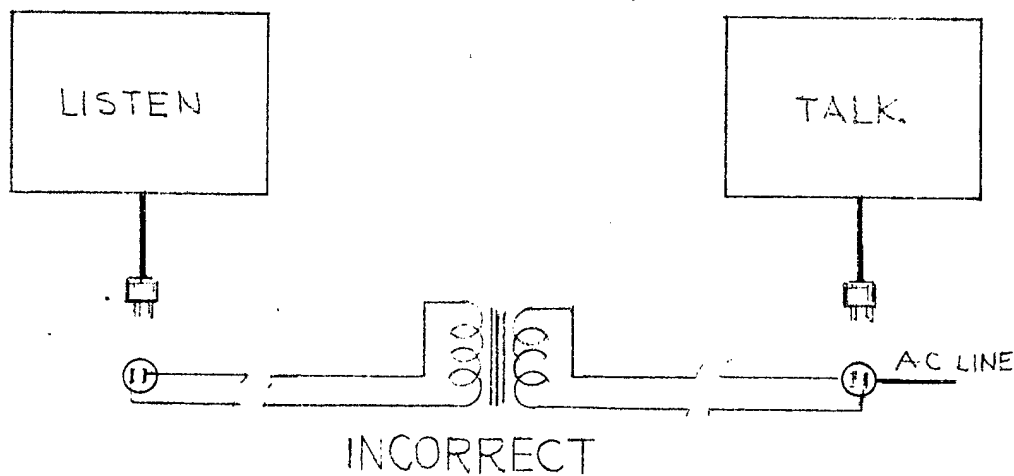
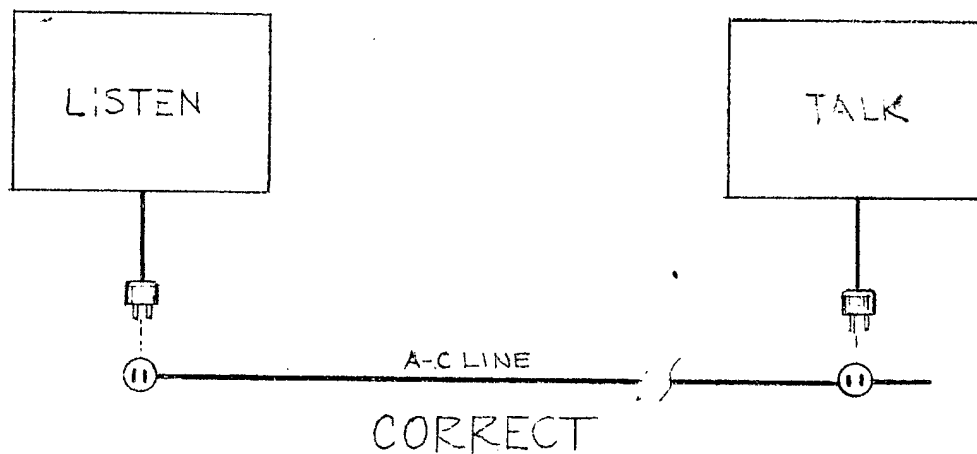
* For LINE operation, output is taken across 1 ohm.

** For TERM operation, output is taken across 500 ohms.

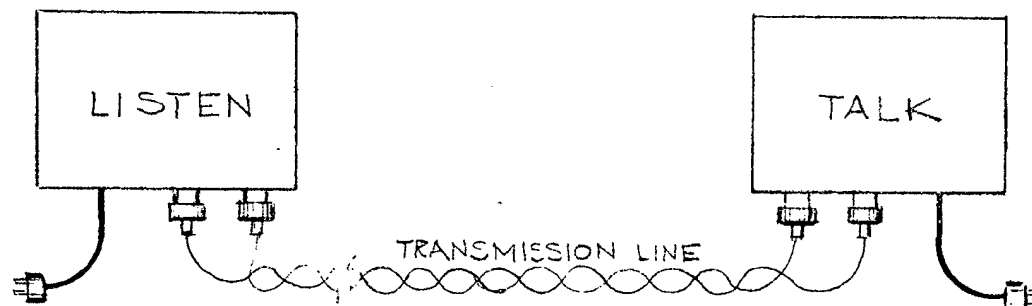
POWER INPUT	STANDBY	OPERATING
115 V, single phase, 60 cps	19 w	27 w
230 V, single phase, 60 cps	21 w	32 w

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POWER LINE CARRIER SYSTEM



EXTERNAL TRANSMISSION LINE CONNECTION

FIGURE 2. System Interconnection Diagram.

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INSTALLATION AND OPERATION

Power Supply Adjustment

Before connecting the line cords to the power outlets, measure the line voltage. Place each station's 115V-230V switch to the setting which corresponds to the line voltage. Failure to do this may cause damage to the equipment.

Installation

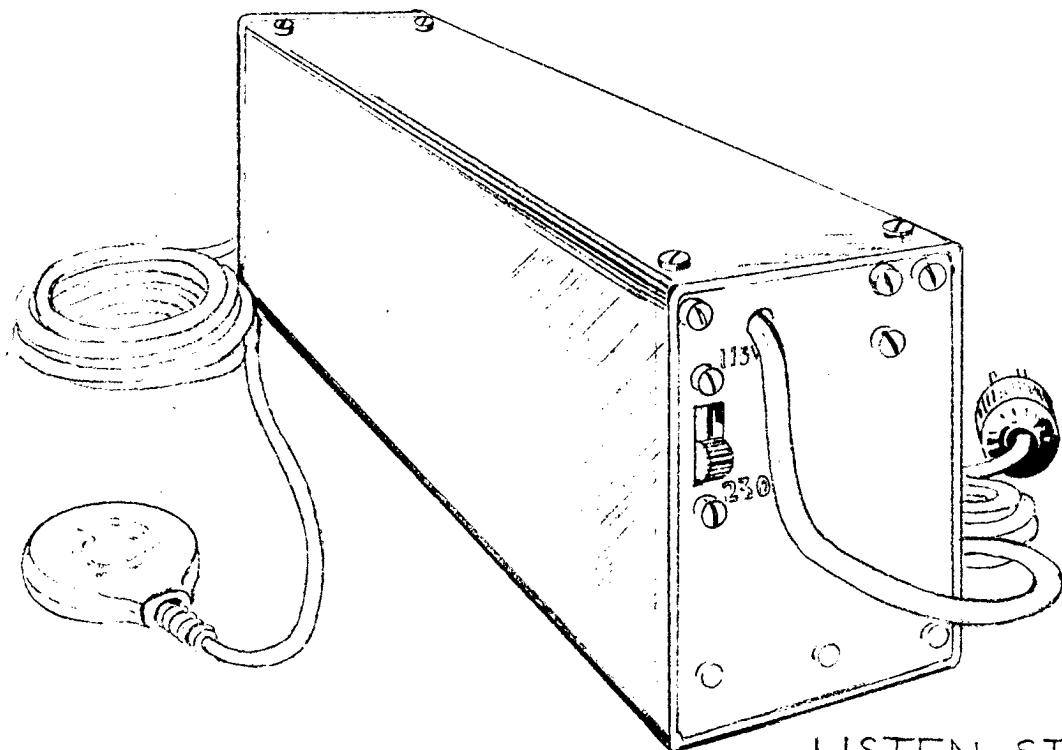
No special orientation is required for the equipment; it will operate in any position. Should mounting brackets be required for a particular installation, they must be fabricated locally. Figure 2 shows alternate methods of connecting the equipment. If the two stations are not separated by a power transformer, the power lines may be used to carry the transmissions. For this type of operation, place each station's TERM-LINE switch to the LINE position. Whenever external transmission lines are used, the switches must be placed to the TERM position. Two pairs of stations, each pair tuned to a different frequency band, may use the same power lines for transmission with no interference between them. Any number of stations may be operated in the same location if external transmission lines are used.

Operation

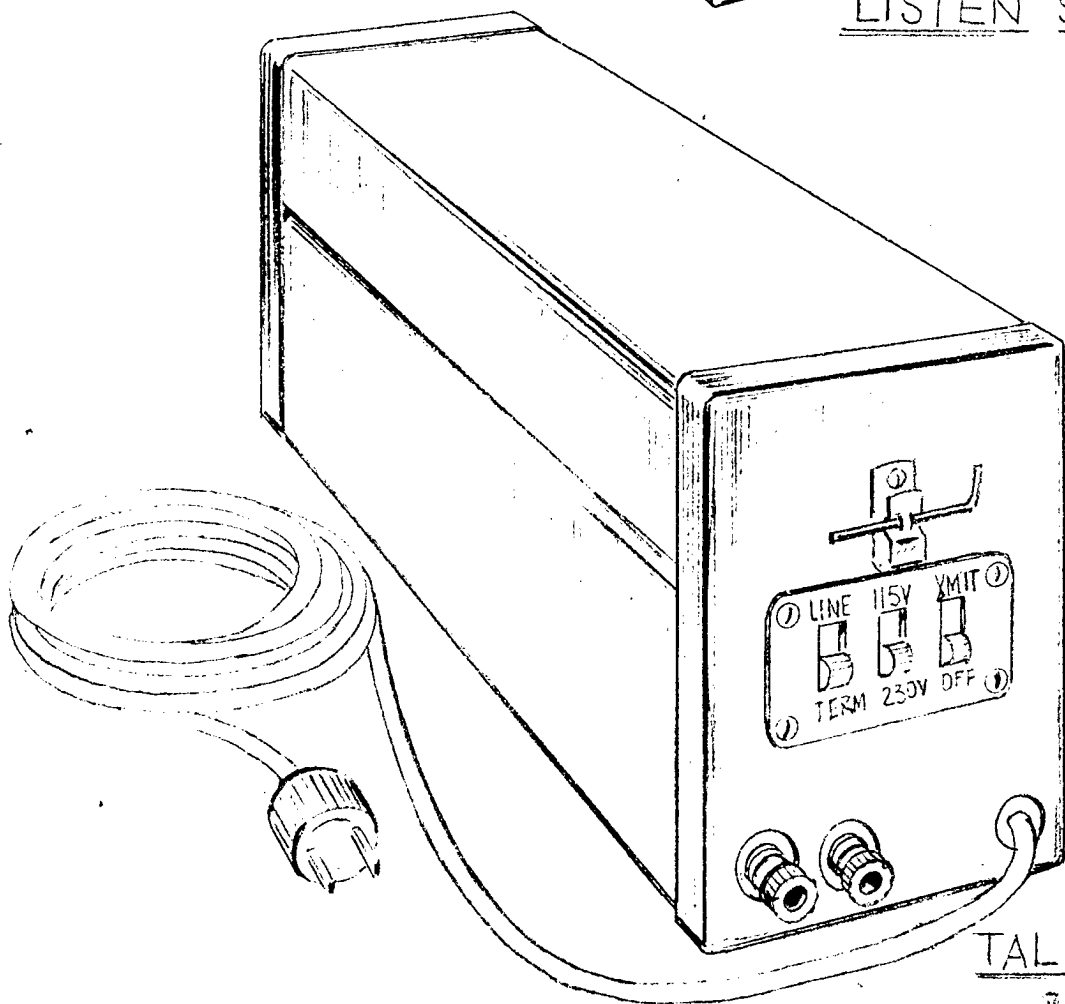
The LISTEN station is on standby when its line cord is connected to an a-c source. Operation is then controlled from the TALK station. This unit is ready to operate when it is connected to the line voltage. Placing the XMIT-OFF switch to the XMIT position energizes the control transmitter whose signal turns on the LISTEN station. To return the LISTEN station to standby, turn off the TALK station control transmitter. Figure 3, a rear view of both stations, shows the location of the controls.

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LISTEN STATION



TALK STATION

FIGURE 3. Portable Intercommunication System, Rear View.

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THEORY OF OPERATION

General

The Portable Intercommunication System is composed of two units and operates in the following manner: the LISTEN station receives the audio through its microphone and amplifies it to modulate an f-m transmitter; the TALK station receives the f-m transmission, demodulates it, and makes the audio available at its speaker or at jacks to which headphones or other devices may be attached. The LISTEN station is controlled by a carrier signal transmitted by the TALK station. This signal actuates a relay in the LISTEN station which applies filament power to the f-m transmitter. Block diagrams of the LISTEN and TALK stations are given in figure 4 and 5, respectively. The following paragraphs describe the operation of the stations. Refer to the schematics at the end of the book for circuit details. For simplicity, only the low band circuitry will be described. The high band circuits are similar; only the values of certain components are changed to produce the different frequencies at which the f-m and carrier channels operate. The schematic diagrams identify these components for each station, and give the values required for each band.

The LISTEN Station

The LISTEN station contains five subassemblies: microphone; audio amplifier; f-m transmitter; control receiver; power supply.

The Microphone

The microphone subassembly contains a modified commercial ceramic unit with a transistor connected in a grounded collector circuit. This provides the impedance transformation necessary to reduce the high impedance at the ceramic

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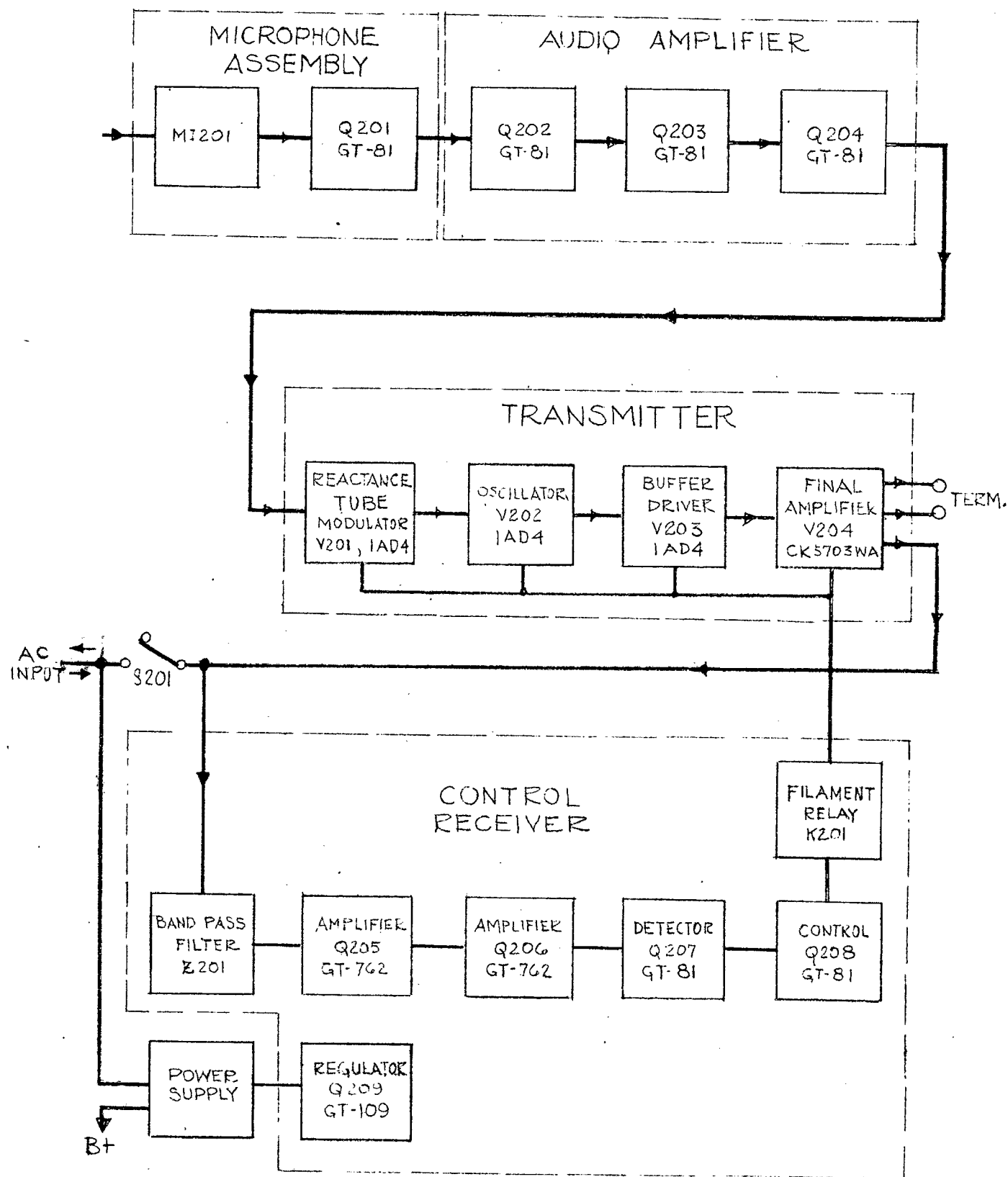


FIGURE 4. Listen Station, Block Diagram.

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microphone cartridge terminals to approximately 1000 ohms, for application to the audio amplifier. This arrangement permits a longer cable to be connected between the microphone and the station while still keeping the hum level down. The cable carries the audio to the amplifier circuitry within the LISTEN station main assembly, and provides the dc to the transistor.

Audio Amplifier

The audio amplifier subassembly consists of a transistorized three-stage amplifier-limiter combination, mounted on a printed-wire circuit board. The limiter output is tapped from the collector load to provide approximately one volt of audio to the modulator when clipping occurs. Limiting in this fashion extends the dynamic-range of the system. A volume control is connected between the first and second stages, and determines the audio level into the microphone necessary to cause clipping in the final audio stage.

F-m Transmitter

Four subminiature tubes form the LISTEN station transmitter. The output of the audio amplifier subassembly is coupled to a reactance tube modulator connected across the tank of an electron-coupled Hartley oscillator operating at 120 kilocycles (low band). The maximum deviation of the oscillator is limited to two kilocycles and occurs when one volt rms of audio is present at the grid of the modulator. A tuned-plate buffer-driver stage couples the oscillator output to the final amplifier, the plate circuit of which is tuned. Two secondary windings are coupled to the plate tank. One secondary, wound to match an impedance of 500 ohms, is joined to the terminals on the housing; a 0.1-microfarad capacitor is used in one side of the line. The other winding, with an impedance of approximately one ohm, has one leg grounded and the other connected

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through a 0.1-microfarad capacitor to the TERM-LINE switch which, when closed (LINE position), couples the output onto the a-c power line.

Control Receiver

The input to the transistorized control receiver section of the LISTEN station is derived from the signal side of the low-impedance secondary winding of T201. When the units are operated in a power line carrier system, the 75-kc (low band) control carrier is present on the power line and is coupled directly to the filter, Z201. When the system is operated with an external transmission line, the control carrier is inductively coupled from the high-impedance terminal winding to the low-impedance line winding, and then applied to the filter. The filter is of the bandpass type with a center frequency of 75 kilocycles. The 6-db bandwidth is 7 kc; the 20-db bandwidth is 11 kc. The 120-kc f-m carrier is attenuated at least 80 db. The filter is permanently tuned and potted. Its output is connected to the first stage in the control receiver.

The remainder of the control receiver components are mounted on a printed-wire circuit board. The signal from the filter is first applied to a two-stage grounded emitter amplifier, then to a detector-amplifier analogous in its operation to a conventional vacuum tube grid-leak detector. The fourth stage in the receiver is normally conducting in the absence of a control signal. Its collector current flows through relay K201 which, in its energized state, holds the contacts open. This interrupts the filament current to the four tubes in the transmitter, and in this manner, keeps the transmitter from operating. When a control signal is received, the resulting positive detector voltage cuts off the fourth transistor, the relay drops out, and the contacts close. This now connects the filaments of the tubes to the power supply and the station is

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turned on. The fifth transistor acts as a regulating element. When the relay de-energizes, the decrease in load current raises the supply voltage. This causes the fifth transistor to conduct more and tends to compensate for the reduction in current, thus keeping the voltage nearly constant.

Power Supply

A-c power to the LISTEN station is applied to transformer T202. The transformer has two primary windings which are connected in parallel for 115-volt operation, and in series when used on 230 volts. The primary also acts as an auto-transformer for 230-volt operation, stepping down the line voltage to 115 volts before it is rectified to obtain the B+ voltage. A selenium rectifier connected in a half-wave circuit provides the B+. An RC filter is used to remove the ripple content. A tapped bleeder provides the lower voltage required by the transistors in the equipment.

The secondary winding of the transformer steps the voltage down to 6.3 volts. When the control relay is de-energized (in the presence of a control signal), this voltage is applied to the filament of the transmitter final amplifier, and also to a full-wave bridge rectifier composed of four germanium diodes. The d-c output of the bridge is filtered and reduced in value by an RC circuit and applied to the three filamentary-type 1AD4 tubes in the transmitter.

The TALK Station

The TALK station contains three main assemblies: the 120-kc (low band) f-m receiver; the 75-kc control transmitter; the power supply.

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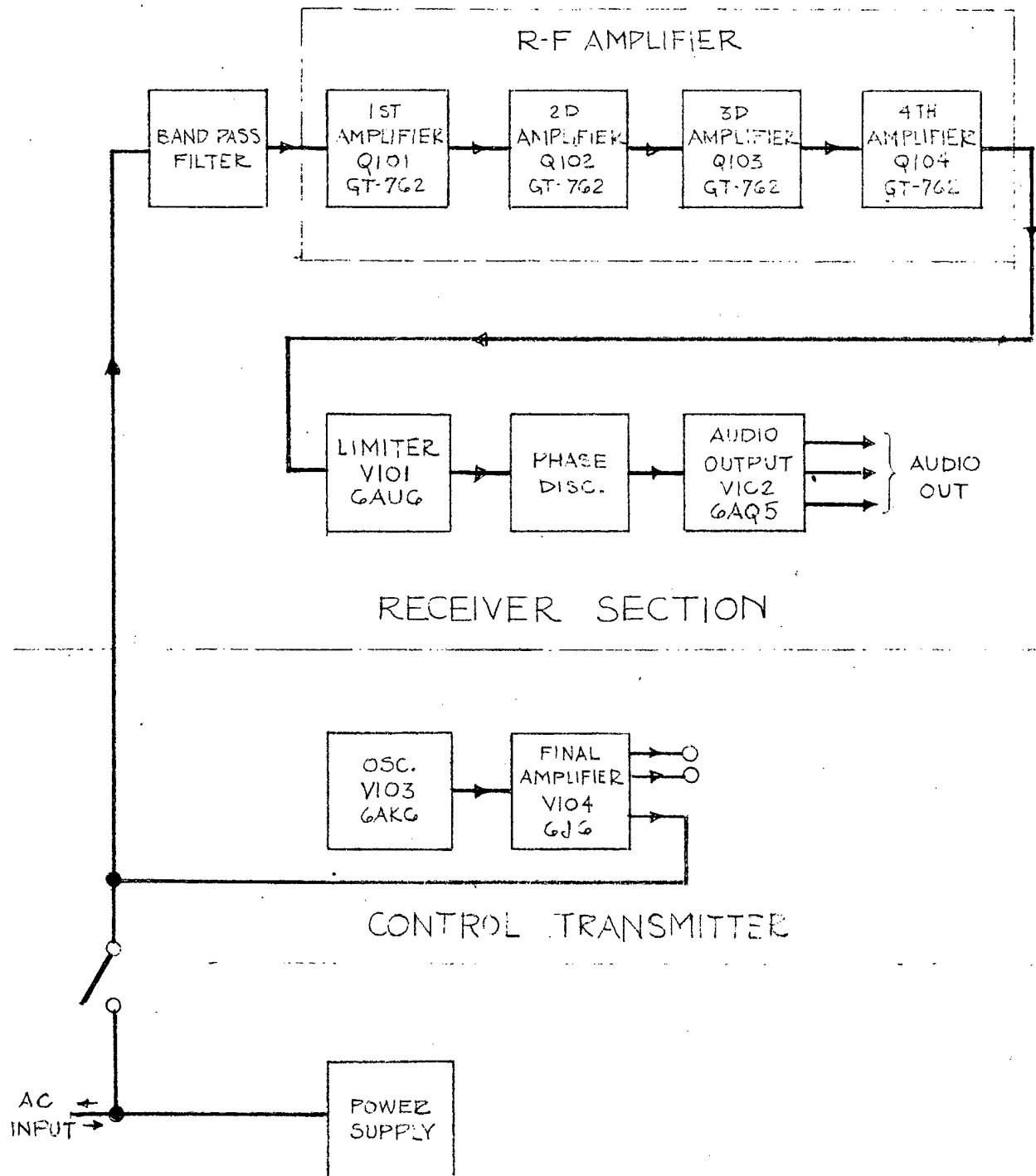


FIGURE 5. Talk Station, Block Diagram.

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The Receiver Section

The receiver section is composed of a four-stage transistorized r-f amplifier, a limiter, a phase discriminator, and an audio output amplifier. The input to the receiver is applied to a filter, Z101, and comes from either the power line or the low-impedance coupling winding of the control transmitter, in a circuit arrangement similar to the one used in the LISTEN station. The filter is of the bandpass type, and permanently tuned to the center frequency of 120 kilocycles. The 6-db bandwidth is 9 kc; the 20-db bandwidth is 13 kc. The 75-kc control carrier is attenuated at least 80 db. The output of the filter is connected to the r-f section where four cascaded transistor stages amplify the signal. The collector load for the last stage is a tuned circuit from which the signal is capacitively coupled to the 6AU6 limiter. This tube stage is provided to insure a constant amplitude signal to the phase discriminator which follows. The audio output of the discriminator is amplified by a 6AQ5 tube and applied to the speaker on the front of the equipment. Two jacks are also available as alternate output sources; the use of any jack will disconnect the speaker. An audio gain control is provided at the input to the audio amplifier.

Control Transmitter

The TALK station transmitter is a two-tube unit composed of an electron-coupled Hartley oscillator driving the final amplifier, a parallel-connected 6J6 tube. The tuned plate of the amplifier is inductively coupled to two secondaries; the 500-ohm secondary winding connects to the terminals on the front of the unit and is used for the external transmission line; the low impedance secondary winding connects to the power line through the TERM-LINE

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switch, as in the LISTEN station. Operation of this transmitter is controlled by the XMIT-OFF switch in the B+ line.

Power Supply

The power supply filament transformer has a center-tapped primary; the entire winding is used for 230-volt operation while only half is used on a 115-volt line. When connected to a source of 115 volts, the transformer primary acts as an autotransformer, doubling the line voltage before applying it to the rectifier circuit. The B+ is obtained from two selenium rectifiers series-connected in a half-wave circuit, and filtered by an RC network. A voltage divider provides the lower voltage required by the transistors.

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MAINTENANCE

Test Equipment Required

The intercommunication system can be serviced with a minimum of test equipment. An a-c VTVM is the only instrument essential for field installation; for bench testing, a signal generator covering the range from 75 kc to 160 kc is required, and some frequency measuring device such as a counter or an oscilloscope.

Servicing the LISTEN Station

To remove the unit from its housing, remove the eight screws from the case (four each on top and bottom), and slide the equipment forward. A metal shield covers all of the components except the filter and the power supply. This shield is held in place by four screws, two each to the front and rear panels. Note that these four screws, and the four screws removed from the top of the phenolic housing, are nylon.

CAUTION

DO NOT SUBSTITUTE METAL SCREWS FOR THE NYLON SCREWS.

It is essential for the safety of personnel that the nylon screws be replaced in their original locations. One side of the a-c line is grounded at the input; the shield, in turn, is connected to this common chassis ground. Depending on the way the line cord is plugged in, the shield may be connected to the hot side of the line. If metal screws are substituted for the nylon ones, voltage dangerous to personnel may be exposed on the outside of the case. This is especially true if the equipment is operated from a 230-volt source. Figure 6 shows the location of the nylon screws.

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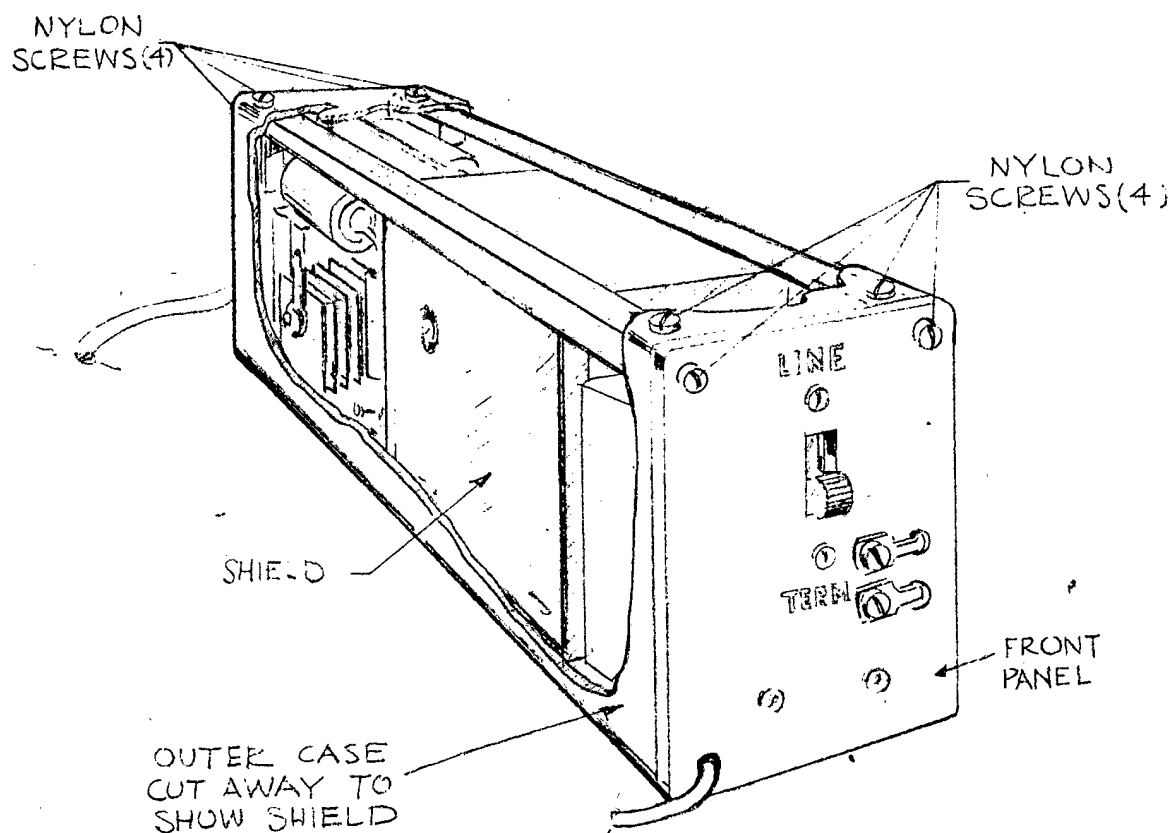
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FIGURE 6. Listen Station, Cutaway View

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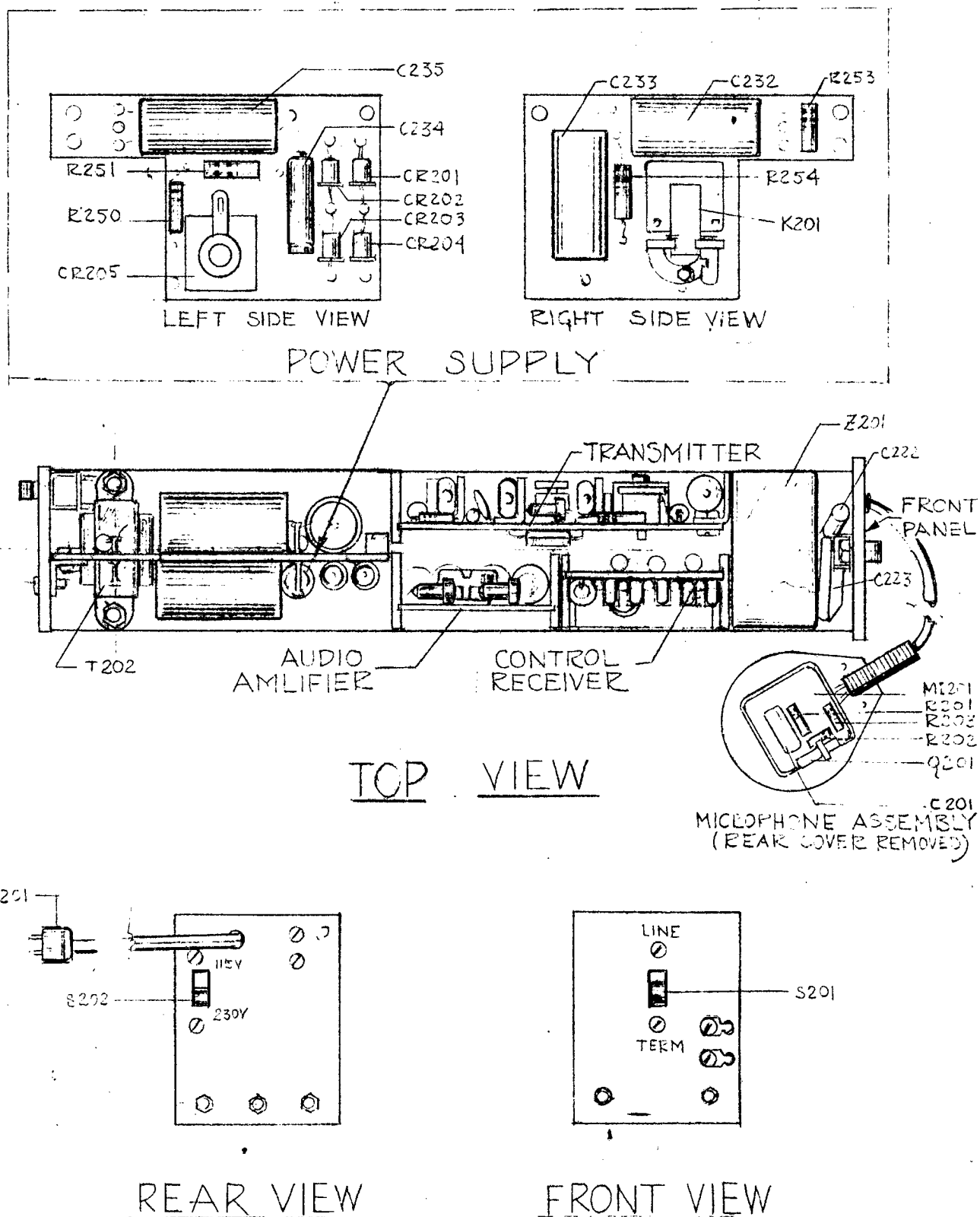


FIGURE 7. Listen Station Main Assembly, Parts Location Diagram.

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When the shield is removed, the remaining components are disclosed. Each section is mounted on an individual printed-wire circuit board which is fastened to the bottom plate, also a printed-wire board carrying the jumpers between the sections. Figure 7 shows the entire station assembly and identifies the major subassemblies and the components in the power supply section. Figure 8 identifies the components mounted on the individual circuit boards comprising the subassemblies.

When replacing transistors or tubes, cut the leads to a 7/32-inch length before inserting them into the sockets. To insert a tube into its socket correctly, orientate the red dot on the tube base with the dot on the socket. When removing components from the circuit boards, apply the soldering iron to the printed wiring where the component lead enters the board, while at the same time lifting the end being heated away from the board.

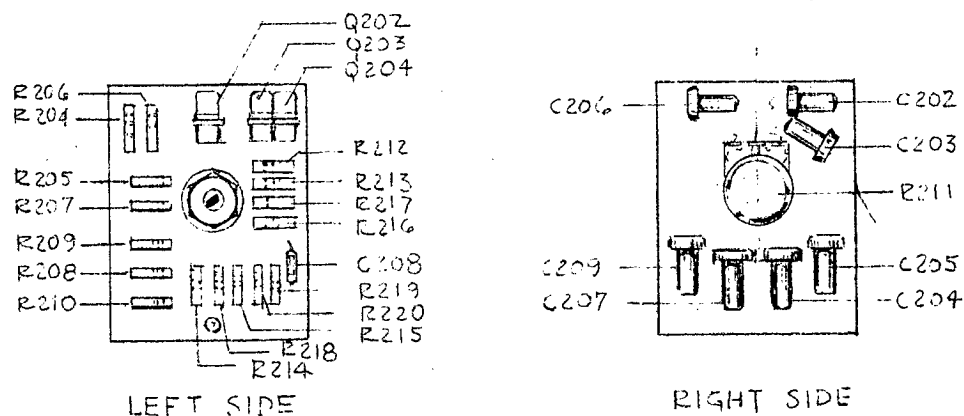
Servicing the TALK Station

To remove the unit from its case, proceed in the following manner. First remove the knob from the front panel audio gain control; a wrench is mounted on the rear panel for this purpose. Next, remove the four screws holding the front panel to the case. The unit itself is secured by five screws on the bottom of the case; once these are removed, the unit may be brought forward out of the case.

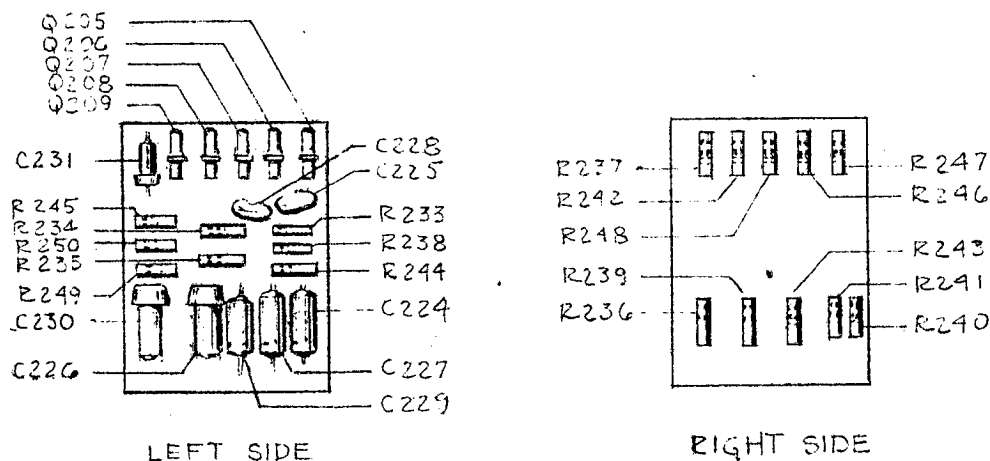
All components are accessible when the unit is out of the case, except the r-f amplifier section. This is a separate subassembly mounted on a printed-wire circuit board and enclosed by a metal shield. Figure 9 identifies all of the components of the station. When replacing the transistors or any of the components of the r-f amplifier section, follow the same procedures outlined above for the servicing of the LISTEN station.

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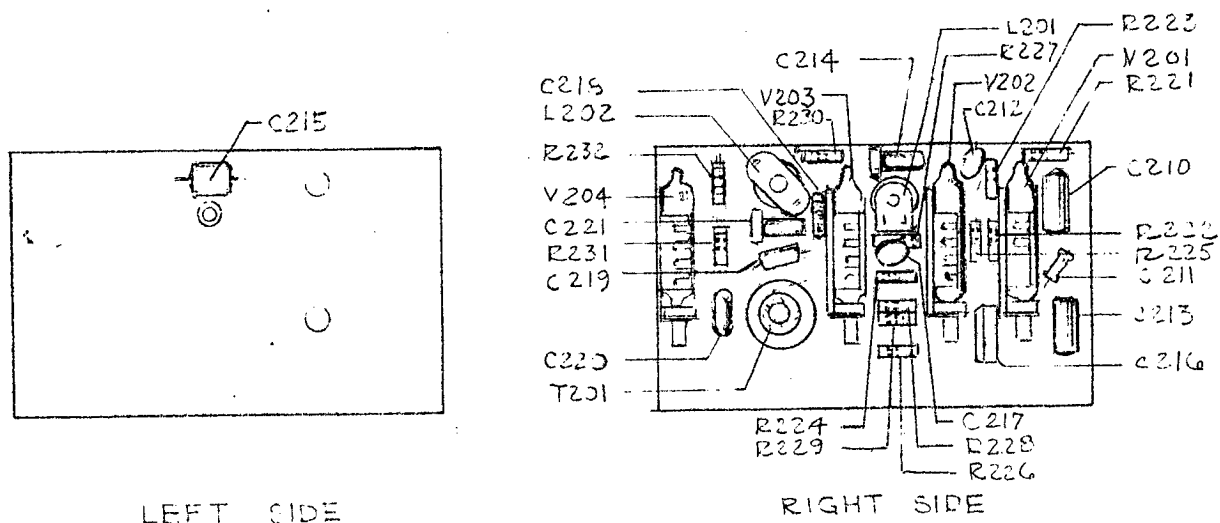
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AUDIO AMPLIFIER



CONTROL RECEIVER

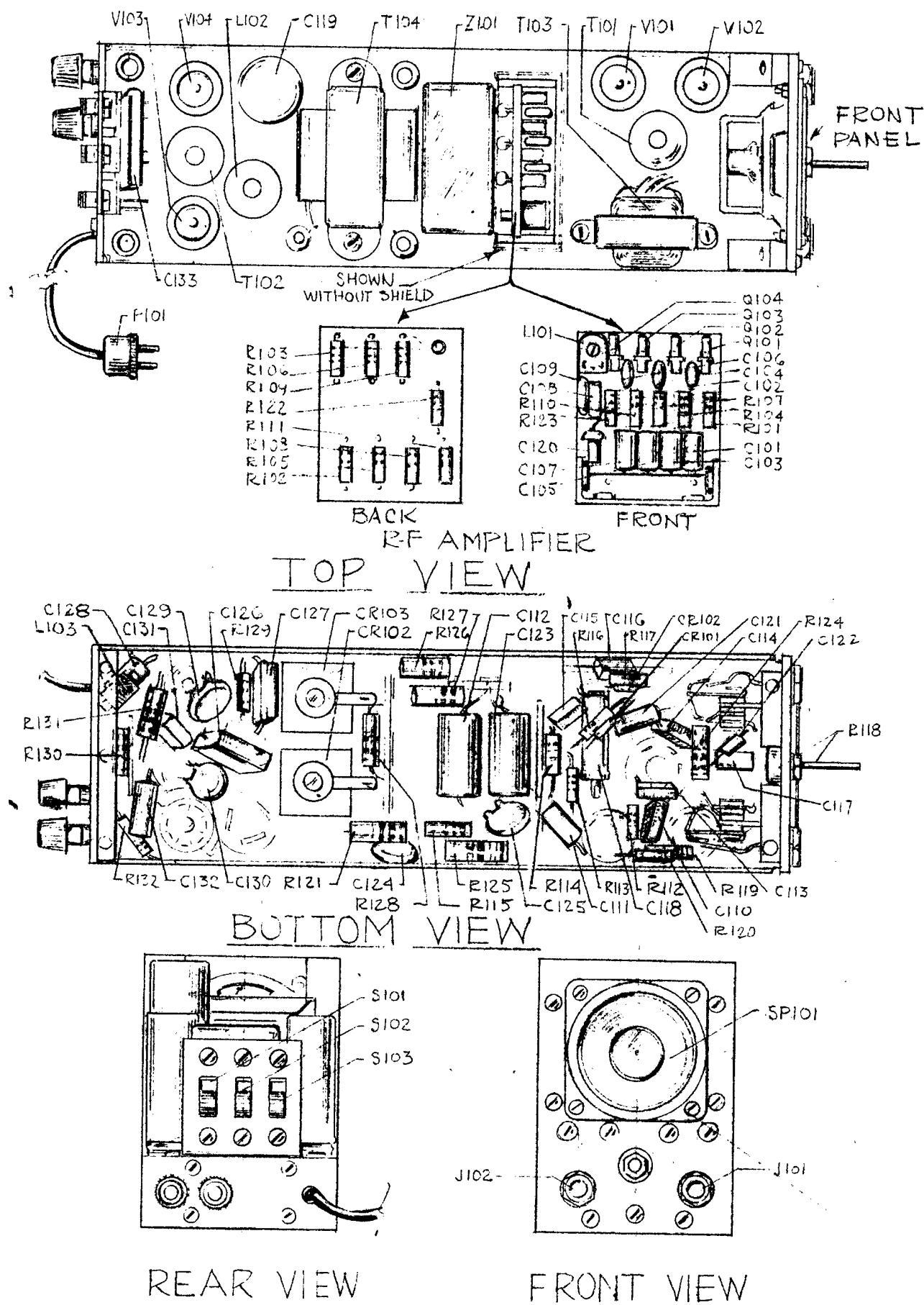


TRANSMITTER

FIGURE 8. Listen Station Subassemblies Parts Location Diagram.

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Aligning the LISTEN Station

Three adjustments are necessary to align the transmitter section, and one to adjust the audio amplifier; the control receiver is permanently tuned. All of the tuning adjustments can be reached by removing the unit from the case; holes are provided in the shield to permit passage of a tuning tool. The tuning slugs are locked in place with wax. To loosen them apply a heat lamp to the local area until the wax has softened enough to allow the slugs to turn.

Before the transmitter can be tuned, it is first necessary to short out the filament relay to permit application of filament current to the transmitter tubes. To do this, connect a jumper across the relay terminals, as illustrated in figure 10.

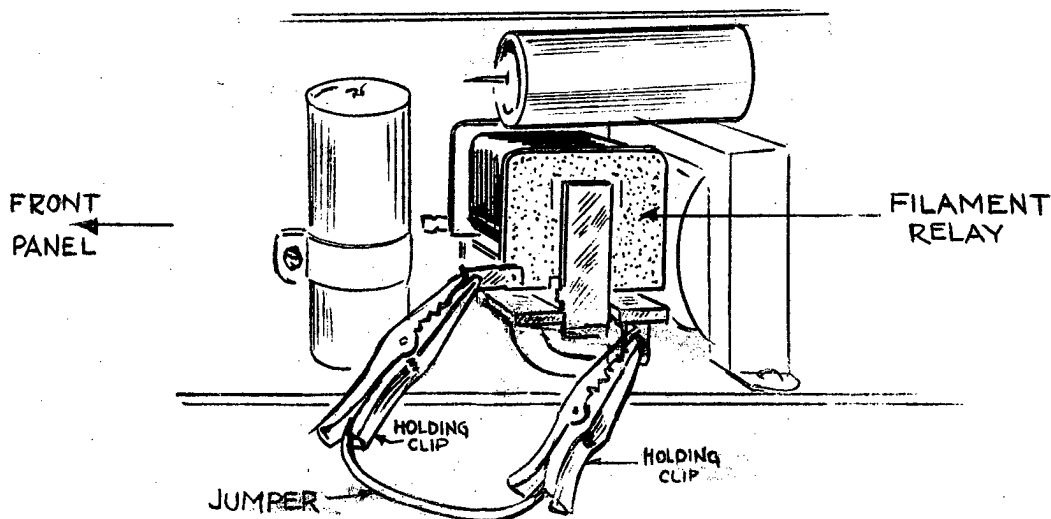


FIGURE 10. Filament Relay Terminals, With Jumper Cable.

In tuning the transmitter, the a-c VTVM is used to measure the r-f voltage at the external terminals. (Place the TERM-LINE switch to the TERM position,

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connect a 500-ohm resistor between the external terminals, and measure the voltage across the resistor.) Frequency may be measured by connecting the frequency meter or the counter to the same terminals, or else the frequency may be compared with a calibrated signal generator using an oscilloscope to obtain a Lissajous figure. To set the frequency, adjust L201 to obtain the desired result (120 kc or 160 kc, depending on the equipment). Then tune L202 and T201, the driver plate and power amplifier tank, respectively, for a maximum indication on the voltmeter (20-30 volts).

Setting the volume control in the audio amplifier section is an adjustment which can best be made at the installation, and will depend on the sensitivity desired. A hole is provided in the side of the outer case to facilitate adjustment of the control. Maximum gain is obtained with the control set to the extreme clockwise position.

If the system is being used as a power line carrier intercom, and the LISTEN station turns on when no carrier is present on the lines, the sensitivity of the control receiver may have to be reduced. To do this, remove R234 from the control receiver circuit board, and replace it with a 10,000 ohm resistor.

Aligning the TALK Station

One adjustment in the r-f amplifier section and two in the discriminator are needed to tune the receiver of the TALK station. Two adjustments are necessary to align the control transmitter. As in the LISTEN station, the tuning slugs are embedded in wax and must be heated before tuning can be accomplished. Most of the selectivity for the voice-modulated carrier receiver is in the permanently tuned filter.

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To repeak the coils, a source of 120 kilocycles (or 160 kilocycles) should be coupled to the power line, the station plugged in to the same line, and the equipment set for power line carrier operation. A LISTEN station can be used as the signal source if the audio gain control is turned down all the way.

L101, the coil in the collector circuit of the last r-f amplifier, is the first tuning adjustment for the receiver. Connect the d-c probe of the VTVM to pin 1 of the 6AU6 limiter tube, V101, through a 1-megohm resistor, and tune the coil for a maximum reading on the meter (10-20 volts). L101 is accessible through the front of the shield covering the r-f amplifier section.

The primary of the discriminator transformer should be tuned next. Connect the d-c probe to the junction marked TEST POINT 1 on the schematic. Tune the top slug of T101 until the meter reads maximum voltage (35-50 volts).

The secondary of the discriminator transformer should be tuned for zero voltage as measured at the junction marked TEST POINT 2. This slug of T101 is accessible from the bottom of the chassis. This completes the receiver alignment.

The control transmitter, located at the rear of the chassis, requires the same frequency measuring set-up as did the main transmitter of the LISTEN station. The unit should be left connected to the power line but the signal source used in the above alignment must be removed. Measurements are made at the external terminals as before. Set the transmitter frequency to 75 kc (or 90 kc) by adjusting L102. Then tune T102 for maximum voltage (25-35 volts).

Field Installation

When placing the equipment into service, a final adjustment may be made to the TALK station receiver section by peaking it to the signal delivered by its associated transmitter in the LISTEN station. At this time the volume control should be adjusted to the desired level.

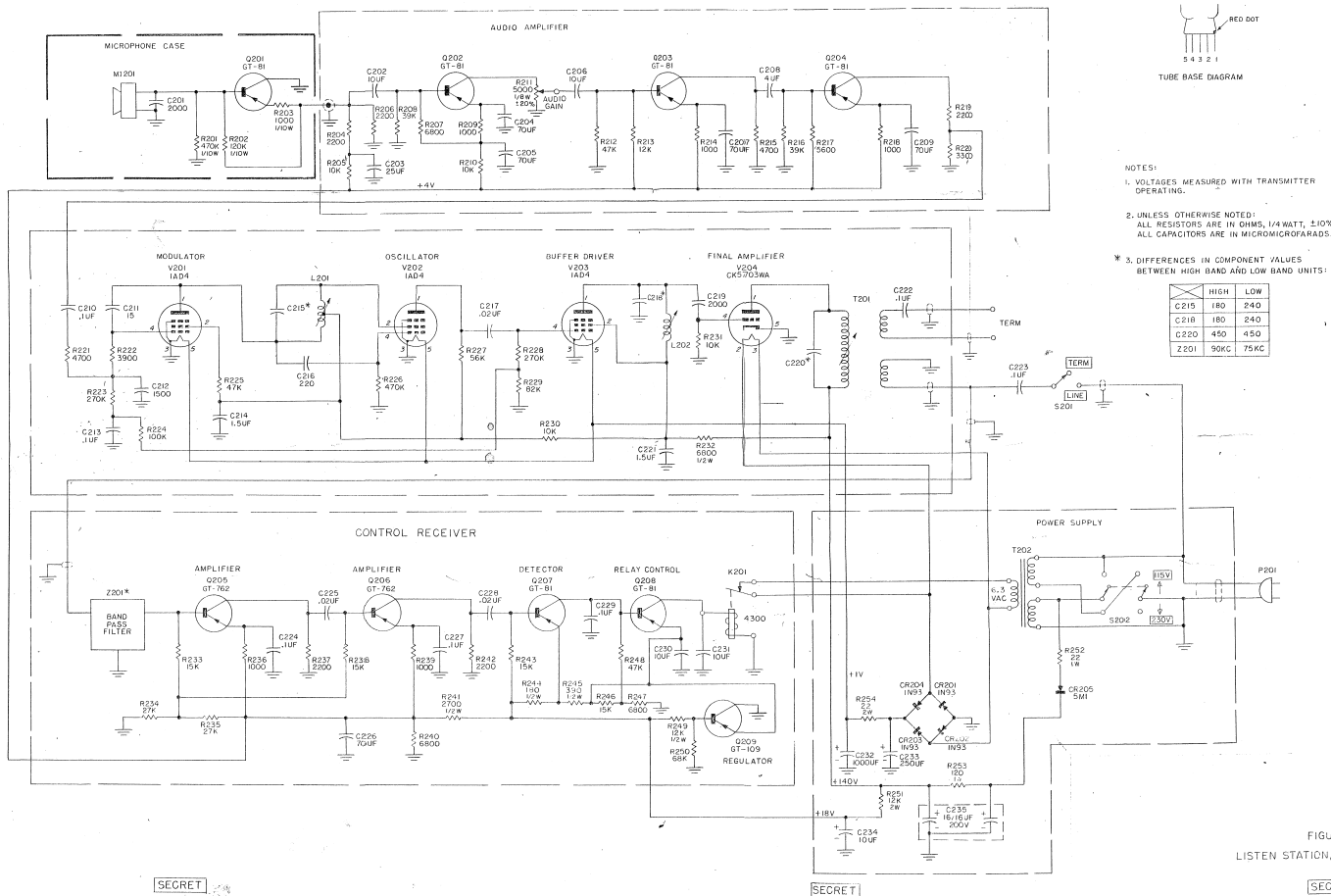
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F-M TRANSMITTER

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FIGURE 11
LISTEN STATION, SCHEMATIC DIAGRAM

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